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THE RELATIONSHIP OF PHYSICAL FITNESS TO ACADEMIC
ACHIEVEMENT OF UNIVERSITY OF MONTANA FRESHMEN

By

Vidvuds Celtnieks

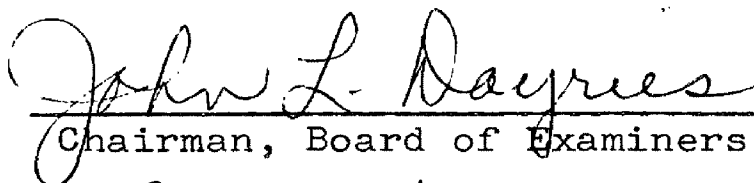
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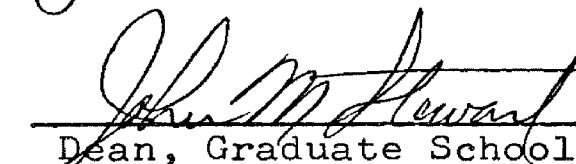
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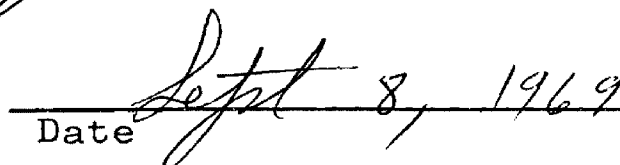
UNIVERSITY OF MONTANA

1969

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V.C.

CHAPTER I

INTRODUCTION

For centuries scientists have studied the relationship between physical and mental factors. Socrates once said:

Why, even in the process of thinking in which the use of the body seems to be reduced to a minimum, it is a matter of common knowledge that grave mistakes can often be traced to bad health.

Plato talked about healthy bodies for healthy minds (12). Aristotle held that body and soul are closely interrelated and that mental faculties are affected by bodily movement and condition of body health. Comenius, a Bohemian educational reformer, noted: "Intellectual progress is conditioned at every step by bodily vigor. To attain the best results, physical exercise must accompany and condition mental training" (12). Rousseau in Emile remarked:

To learn to think we must therefore exercise our limbs, our senses, and our bodily organs, which are the tools of the intellect; and to get the best use out of these tools, the body which supplies us with them must be strong and healthy. Not only is it quite a mistake that true reason is developed apart from the body, but it is a good bodily constitution which makes the workings of the mind easy and correct (7).

Locke (10) wrote that:

A sound mind in a sound body is a short but full description of a happy state in this world. He that has these two has little else to wish for. He who

wants either of them will be little better for anything else.

More recently, Sherrington (10), the British physiologist, stated that "the muscle is the cradle of recognizable mind." That the mind and body are interdependent was succinctly expressed by Menninger (5) in the following passage:

Mind depends upon the sensory nerve endings in the skin and the motor nerve endings in the muscles; it depends upon the muscles themselves and to some extent upon all physical structures of the body.

Not everyone agrees with this concept. Cattell (18) said that: "The association of a healthy mind with a healthy body is still not a proven fact. Research must show whether organic and psychological condition are associated." Although this research is individually inconclusive, Cattell believed that physical and mental traits were completely independent of each other.

Aldous Huxley, criticizing the science of psychology, wrote these words:

What is, I suppose, the most serious, as it is certainly the most conspicuous shortcoming of all . . . the absence of any mention of the body as a conditioning factor in the formation of the mind, or as a determinant of thoughts, feeling, and behavior (2).

Though this criticism was fairly accurate at the time of its writing, it is no longer valid. In the past decade a growing interest in the relationship between the mind and body has been evident. Modern psychologists such as Johnson, Kephart, and Olson believe that the first

learning experiences of a child occur through the senses of taste, smell, touch, sight, and hearing. Later the child begins exploring the world by identifying and relating the body and its parts to objects in space. The child, in making these explorations, learns to communicate in a rudimentary fashion and learns to stimulate himself physically. Both Jacobs (34) and Johnson (37) agree that a dynamic "body image" or basic self-concept evolves in this way and with it a foundation is laid for further learning through movement. Movement through the physical becomes the earliest medium for social interaction, for developing a definite personality structure, and for abstract reasoning which may be associated with directed creative play.

On the basis of the preceding statements and the fact that it has been commonly observed that people who are physically fit can and do demonstrate a greater persistence in a variety of mental and physical tasks, the following study was undertaken.

I. THE PROBLEM

Statement of the Problem

The problem of this investigation was to determine the relationship between physical fitness and academic achievement of the University of Montana freshmen.

Significance of the Study

If a relationship between physical fitness and academic achievement exists, then perhaps physical fitness could be used to predict a student's success in college. It is possible that this study might add insight into the relationship between physical fitness and academic achievement. More value might be assigned to physical education in the total education of the student. Additionally, a student's success in college might be enhanced if the physical variables that contribute to academic success are identified and developed.

Limitations of the Study

1. This study was limited to 108 volunteer freshman males enrolled in physical education activity classes during the 1969 spring quarter at the University of Montana.
2. This study was limited to freshmen with a minimum of twenty accumulated quarter hours for the 1968 fall and 1969 winter quarters with no reference to their major field of study.
3. No attempt was made to improve the physical fitness level of the subjects.
4. No attempt was made to determine how the subjects arrived at their physical fitness level.
5. This study was limited to the cumulative grade point average in determining academic achievement.

6. This study was limited to the Rogers' Physical Fitness Index to measure physical fitness.

7. This study was limited to one test administration of the Rogers' Physical Fitness Index.

II. DEFINITION OF TERMS

For purposes of clarification and understanding, the following terms and definitions were used in the study.

Grade point average: refers to the cumulative academic index as determined by the University of Montana registrar's office. The index of a student is the ratio of quality points to his total number of hours. Grading is based upon a four-point system: 4.0=A; 3.0=B; 2.0=C; 1.0=D. In this study, grade point average will be referred to as GPA.

Physical fitness: refers to the functional capacity of an individual for a specified task or job in which fitness is judged. One who is fit can perform a task repeatedly without undue fatigue, and possesses enough reserve capacity to be able to meet and sustain any unexpected stresses which might arise.

Rogers' Physical Fitness Index: refers to a measure of strength relative to the individual's sex, weight, and age. It is derived from the following maximal tests: pull-ups, push-ups, right and left hand grips, back and leg lifts,

and lung capacity. In this study Rogers' Physical Fitness Index will be referred to as PFI.

Endomorphy: refers to a physique with an overabundance of fatty tissue and weight in relation to height. The following description characterizes the endomorphic physique: a large round head with a thick short neck, broad thick chest with fatty breasts, short arms, a large abdomen full above the navel, heavy fat buttocks, generally short heavy legs, narrow shoulders, and broad hips with fleshy area above the iliac crest.

Mesomorphy: refers to a physique with a heavy, hard, rectangular outline with large prominent bones, long strong neck, fairly low thoracic trunk, broad shoulders, muscular upper arms, strong forearms, heavily muscled abdomen, slender low waist, narrow hips, heavy buttocks, and strong powerful legs.

Ectomorphy: refers to a physique where linearity and fragility prevail. This physique is characterized by a slender, frail body structure with small bones and thin segments, large head with bulbous forehead, small facial bones, sharp nose, pointed chin, long slender neck, long narrow chest, a tendency toward winged scapula and round shoulders, long arms, and a very flat abdomen hollow above the navel. The buttocks are inconspicuous, the legs are long and thin with pipestem bones, and general musculature is not marked (13).

CHAPTER II

REVIEW OF RELATED LITERATURE

The following review of literature has been organized into six categories. The first category discusses those studies that have related body type to intelligence and/or academic achievement. The following four categories discuss those studies that have related similar variables but have used subjects that vary primarily in chronological age and physical maturity. Therefore, elementary, junior high, high school, and college categories were used. Finally, those studies that have compared the academic achievement of athletes to non-athletes are discussed under a separate category.

I. PHYSIQUE STUDIES

Many of the earlier studies compared body type to intelligence. For example, in 1921, Naccarati (47) measured seventy-five university students and differentiated body types according to a ratio of limb length to trunk size. Based upon this procedure, the following classifications were devised: (1) macrosplanchnics, described as having relatively large trunks compared to limb length; (2) microsplanchnics, those individuals with relatively small trunks in comparison to limb length; and (3) normosplanchnics,

those individuals with medium trunks relative to limb length. On the basis of comparing intelligence to an index of body type, Naccarati found a correlation of .36 between microsplachnics and intelligence as measured by the Thorndike Entrance Examination.

In 1924 Sheldon (56) replicated Naccarati's investigation utilizing 450 students entering the University of Chicago. He found a correlation of .136 between microsplachnics and an intelligence rating and a correlation of .114 between microsplachnics and grades. Later, Sheldon developed a system of somatyping human physiques based on a patterning of the morphological components of an individual. He used the terms endomorph, mesomorph, and ectomorph as general classifications of the various body types.

In a recent longitudinal study, Moutis (46) analyzed the relationship of academic achievement to selected maturational, structural, strength, and motor characteristics of boys ten through twelve years of age. He found that boys who were superior in standing and sitting, height and maturity, as measured by skeletal age, received significantly higher grades. In addition, he reported that boys with higher grades demonstrated ectomorphic features to a greater degree than boys with lower grades.

In a similar study Jarmon (35) compared the academic achievement of nine, twelve, and fifteen-year-old boys to

selected maturity, physique, strength, and motor measures. He found that boys with ectomorphic features had higher grades than did mesomorphic and endomorphic boys.

II. ELEMENTARY SCHOOL STUDIES

Numerous studies have been done with elementary school children comparing a variety of motor skills to school success. Kephart (3) feels that some kind of motor activity underlies all behavior, including higher thought processes. He also states that motor skills are valuable in developing all around school preparedness and that in order to fully prepare children for the types of activities that they will encounter in the school program, certain developmental experiences are necessary. Therefore, children need to develop rhythm, a sense of laterality and directionality, bilateral arm and leg movements, balance, form perception, and other sensory-motor activities.

After studying seventy-five second grade boys and girls, Fox (27) concluded that there was a positive relationship (49) between reading skills and dynamic, static, and rotational balance. Adding more strength to Kephart's motor bases, Plack (49) found highly significant correlations between reading achievement and the throw and catch test and zig-zag run test in elementary school children. Similarly, McCormick et al (44) matched forty-two first grade reading

underachievers on the basis of age, sex, intelligence, and reading level, according to the Lee Clark reading level test. They were randomly assigned to a perceptual motor training group, a regular physical education group, and a control group. After seven weeks the perceptual motor training group made significant grade level gains in reading when compared to the other two groups.

Ismail et al (33) found positive relationships between motor aptitude test items, most notably coordination and balance, and well established measures of intelligence and scholastic ability. Moutis (46), in agreement, found that those scoring high in the sixty-yard shuttle run and standing broad jump were rated high scholastically.

Utilizing nine-year-old boys as subjects, Day (23) found a low but positive correlation of .143 between the standing broad jump and intelligence. Conversely, Page (48) found a significant correlation between academic achievement and the standing broad jump in favor of the low academic group.

Rarick and McKee (50) categorized twenty third grade children into high and low motor ability groups on the basis of various motor efficiency tests. They found that in the high motor ability groups, seven out of ten had IQ scores above 110, whereas only two out of ten had IQ scores greater than 110 in the low motor ability group. They also found

that children in the high group were more popular, active, resourceful, attentive, cooperative, and had a wider range of interests.

Trussell (64) tested the relationship between reading readiness and the Frostig tests of motor ability of seventy-five elementary school children. She found that chronological age was a more significant determinant of reading readiness than were the Frostig tests. Except for a negative correlation ($-.27$) between the hurdle jump and the Stanford Achievement Test batteries, Thompson (63) found little evidence of a relationship between motor skills and mental achievement of sixth graders.

Physical maturity seems to play an important role in academic achievement, especially at the elementary school level. In Britain, Brace (15) found that only 2.36 per cent of above average students in scholarship were below average in physique, whereas 39.7 per cent with poor scholarship were below average physique. Physique was determined by body measurements of weight and height. In the same report, Brace (15) concluded that St. Louis school children who were below average scholastically were lighter, whereas those who were above average scholastically were heavier. Moutis (46) in a similar study of boys ten to twelve years of age, concurred with those results.

In a study of 1,000 intellectually superior children,

Terman (62) concluded that intellectually superior children were not characterized by a deficiency of play and that: "There is no shred of evidence to support the widespread opinion that, typically, the intellectually precocious child is weak, undersized, or nervously unstable."

III. JUNIOR HIGH SCHOOL STUDIES

A variety of research has been conducted at the junior high school level in comparing selected physical variables to academic achievement.

Miller (45) found a positive significant correlation between power, as measured by the vertical jump test, and scholastic class rank.

Thomas (63) studied the relationship between physical fitness, IQ, and the GPA of seven semesters of seventh and eighth grade girls. She found significant positive correlations of .49 between physical fitness and seven semester GPA and .45 between physical fitness and IQ of the seventh graders. At the eighth grade level she found a positive correlation of .37 between seven semester GPA and physical fitness and a positive correlation of .34 between IQ and physical fitness.

Buckellew (17) studied fifth, sixth, seventh, and eighth grade boys using the AAHPER Fitness Test and compared the results to intelligence, as determined by the

California Mental Maturity Test, and academic achievement, as measured by the Iowa Test of Basic Skills. Significant positive correlations, up to .294, were found between language and sit-ups, standing broad jump, and the 600-yard walk and run.

Physical fitness and intelligence of high and low achievers have been compared. Sundholm (60) tested a high and low intelligence group of junior high school girls with a general motor capacity test and found a significant difference in mean scores in favor of the high intelligence group.

Clarke and Jarmon (20) categorized nine, twelve, and fifteen-year-old boys into high and low PFI groups and found that the high PFI groups had significantly higher academic measures as demonstrated by GPA and scores of the Standard Achievement Test than did the low PFI groups.

High fitness groups do not always have a higher GPA than low fitness groups. In a study of 105 fifteen-year-old boyd, Jarmon (35) found a significant negative relationship between academic achievement and strength and endurance. Academic achievement was determined by the Iowa tests of Educational Development, GPA, and Otis Quick Scoring Mental Ability Test, and strength and endurance determined by the PFI Test. Page (48) concluded that the low PFI group had a higher GPA than did the high PFI group at age thirteen and

sixteen.

IV. HIGH SCHOOL STUDIES

The comparison of physical fitness and academic achievement has not only varied in measures used but also in results gained. A number of studies have compared physically active to physically inactive students.

By studying the class average of 432 high school boys in physical fitness and academic achievement, Ray (51) found that boys not enrolled in physical education during part of their high school career showed general inferiority to the class average in the two areas. Additionally, students not enrolled in physical education failed twice as many academic subjects as those who did enroll. Physical education grades were not used in determining overall cumulative gradepoint.

Hines (32) found that high school students with low physical fitness indices often failed one or more subjects, even though their IQs were high. He elaborated on case studies of students with low PFI scores who improved their school grades as they improved their PFI. Low PFI scores also have indicated some health defencts, which might otherwise have gone undetected. Some students who scored 140 and above on the PFI were likely to be too nervous, poor sleepers, undernourished, disciplinary problems, and even poor scholars.

Hines suggested that the students with PFI scores above 140 redirect their energies into more academic and cultural activities. He concluded that by improving the PFI a person's GPA could also be improved.

McCollum (43), using the AAHPER Fitness Test, selected twenty-eight fit and twenty-eight unfit boys from 172 high school male students and found that the fit group had an average GPA of 2.68, whereas the unfit group had an average of 1.91.

Walker (66) categorized twelfth grade boys into gifted, average, and special groups according to IQ scores. He found that the lower the group was in IQ the lower they were in physical fitness and the higher they were in IQ the higher they were in physical fitness.

V. COLLEGE STUDIES

So far, little mention has been made of the women. Studies of college women (30, 53, 14) have shown a significant positive relationship between GPA, physical fitness, and skill measures.

In comparing the PFI of sixty freshman women to their cumulative academic index, Hart and Shay (30) found a positive correlation of .63 significant at the .01 level.

Arnett (14) found a significant correlation of .556 when she compared a physical fitness score derived from the

variables of height, weight, broad jump, arm hang, curl-up, and step test to the GPA of 827 college women.

Not all studies have shown as positive a relationship. In a study of women physical education majors at Brigham Young University from 1957 to 1964, Hawkes (31) found a negative correlation of $-.444$ between a motor ability test and GPA in the 1961-1962 school year.

In a study of male college students, Gutin (29) administered the Employee Aptitude Survey, which consisted of verbal comprehension, visual pursuit, verbal reasoning, and symbolic reasoning, and the Indiana Motor Fitness Index II, which was a sum total of push-ups, standing broad jump, and pull-ups. Afterwards he administered a stress test which included a one-minute step-up test, twenty-five long addition and subtraction problems, and concluded with a one-minute step-up test. After a twelve-week physical training program for one group, both groups were administered the stress test. Gutin found no significant differences between the groups. However, he did find a positive correlation of $.355$ between physical fitness improvement and degree of mental task improvement in the training group.

At Ohio University, Coates (21) administered skill tests in the softball throw, soccer kick, tennis ball stroke, and jumping events to a student group of juniors,

seniors, and graduates and compared them to a drop-out group. The student group of juniors, seniors, and graduates were significantly superior (.34) to the drop-out group on all the skill tests.

Doornick (25) reported on the academic success of 1,338 men during their four years at the University of Oregon. He found a positive correlation of .29 between PFI and GPA. All freshmen had a forty per cent chance of graduating and a twenty per cent chance of winning a scholarship. Seven per cent of students with the lowest PFI had a twenty per cent chance of graduating and a one and one-half per cent chance of winning a scholarship. The upper seven per cent in PFI had eight times as many chances of winning a scholarship. Chances for graduation decreased with the lower levels of physical fitness.

Since this study concerns male college freshmen, the author will now relate a number of studies that have used college students as subjects.

Weber (67) investigated the relationship between PFI and GPA of 264 male freshmen at the University of Iowa. He found a positive correlation of .41 between physical fitness scores and GPA, and a multiple correlation of .666 when physical fitness scores and composite entrance examination scores were related to the GPA during the freshman year.

At Springfield College (30) the PFI of 269 freshmen was compared to their GPA. Students with PFI scores of 115 and above had a mean GPA of 2.01, those ranging from 100 to 114, a mean GPA of 1.94. In addition, students with PFI scores from 85 to 95 had a mean GPA of 1.85, and those students scoring below 85 had a mean GPA of 1.51.

Page (71) studied the freshman students who were dismissed at Syracuse University during the 1939-40 school year. He found that eighty-three per cent of those dismissed had physical fitness indices lower than 100, whereas only thirty-nine per cent of freshmen dismissed had PFI scores above 100.

At the University of Oregon, Coefield and McCollum (22) found that the seventy-eight freshmen with the lowest PFI scores had a GPA of 1.84 compared to all other freshmen with a 2.45 GPA.

In another study, Wilson (68) compared the GPAs of a high PFI group to the GPA of the low PFI group and found that even though the predicted fall GPA of the low PFI group was greater than the high PFI group, the high PFI group achieved a higher fall GPA.

Johnson (36), however, found no relationship between the physical skill and intelligence of 310 Denver College freshman students.

Jones (38) evaluated 101 Indiana University freshmen

with the Fleishman Basic Fitness Tests. When the men were separated into high, average, and low groups on physical fitness, a negative significant correlation was found in the high group between physical fitness and academic aptitude.

VI. STUDIES OF ATHLETES

For many years athletes have been stereotyped as academically inferior to other students. According to recent research on this topic this belief has not been substantiated. Stafford (59), in a longitudinal study of elementary and junior high school students, compared athletes to non-athletes and found that the athletes were superior to non-athletes on GPA, mathematics grades, English grades, and social studies grades.

Eidsmoe (26) studied twelve members on each basketball team in the 1961-62 Iowa boys regional and state tournaments. He compared their first semester grades to those of the other students in the classes. The 168 players had a 2.56 average compared to 2.186 for all other members.

Jones (40) conducted a study from 1964 to 1966 comparing high school athletes to non-athletes on academic achievement, which was measured by the Iowa Test of Educational Development and GPA. Athletes participating in football, track, golf, baseball, tennis, and cross country were significantly superior in academic achievement to non-

athletes. No significant difference was found between the academic achievement of wrestlers and non-athletes.

Shafer and Armer (55) studied the GPA of 585 high school boys, of whom 164 were athletes. The athletes' average GPA was 2.35, compared to 1.83 for the non-athletes.

Jones (40) compared high school athletes to non-athletes on IQ and found that athletes were represented on a proportional basis in the average and above average intelligence groups, but were fewer in the low group. This might be due to the eligibility requirements for athletic participation.

Smith (58) found that athletes participating in intercollegiate sports had lower grades than non-athletes during the season. However, these differences were compensated for by increased academic achievement during the off season.

It is interesting to note that participants in individual sports, except wrestling (39, 40, 55), generally have a superior GPA than those participating in team sports. Studies by Shafer and Armer (55) and Jones (39) concur with this finding. Jones (39) concluded that high academic achievers tended to select those individual non-contact sports that can be carried over into adult life, such as tennis, golf, and cross-country.

VII. SUMMARY OF REVIEW

In summarizing the literature, the majority of studies indicate a rather low positive significant relationship between physical fitness and academic achievement. Some studies show no relationship, while others indicate a negative relationship. It appears as if a disagreement exists as to the actual relationship. To complicate the topic, a variety of tests to measure physical fitness and academic achievement have been used to determine whether a relationship exists. The physical measurements were determined by body type, general motor ability, motor skill, and fitness, and have been compared to the academic variables measured by mental aptitude, mental maturity, intelligence, scholastic rank, and grade point average. At elementary, junior high, senior high, and college levels, ectomorphic features of boys correlated with academic success, while endomorphic and mesomorphic features did not.

Motor skill items of balance, coordination, and jumping ability were important in the academic success of elementary school children. Physical maturity, height, and weight were also contributing factors to the academic success.

Some junior high studies produced a positive correlation between high PFI and academic achievement. In most junior high as well as in senior high studies the standing

broad jump correlated with academic achievement.

Physical fitness determined by the PFI and the AAHPER Physical Fitness test was positively correlated to academic achievement at the high school level.

Generally, studies of college students indicate a positive correlation between physical fitness measures and academic achievement. Most studies of college women show a positive correlation between height, weight, broad jump, arm curl, step test, curl up, motor ability, and academic achievement. Softball, soccer, tennis, jump and reach skills and PFI correlated significantly to academic success of college men.

College freshmen with high PFI were academically superior and had a better chance of graduating than students with low PFI. Motor skills compared to academic success showed no correlation.

Studies involving athletes indicate a higher GPA in comparison to non-athletes. The reader must be critical of such studies since eligibility requirements must be maintained in order to participate in athletics. Therefore, athletes with low GPA were eliminated, resulting in an invalid sample.

Since the majority of the information available on this subject exhibited differing results, it appeared worthwhile to conduct an additional study in hopes to contributing more information in this area.

CHAPTER III

PROCEDURES FOR MEASURING PHYSICAL FITNESS AND ACADEMIC ACHIEVEMENT

I. SUBJECTS

The subjects were 108 male freshman students enrolled in physical education activity classes during the spring quarter of 1969. Of these freshmen, sixty were majors in the College of Arts and Sciences, thirty-three were in the professional schools, and fifteen were undecided as to their major. At the time of the test, forty-nine were eighteen, fifty-one were nineteen, and the rest were twenty, twenty-one, and twenty-two years of age. All of the group were enrolled at the University of Montana in the fall of 1968 without any previous college experience. Data gathered for this study included the cumulative academic indices for fall and winter quarter 1968-69, and the Rogers' Physical Fitness Indices as of May 7, 1969. Additional information collected was for the total number of credit hours and major field of study.

II. ROGERS' PHYSICAL FITNESS INDEX TEST

The Rogers' Physical Fitness Index Test was used in this study to measure the physical fitness of freshman

students. In order to discuss the topic of physical fitness, we must first define it. Physical fitness is the capacity of an individual to perform specific tasks requiring muscular activity without undue fatigue. Therefore, the PFI measures the capacity of an individual to engage in strenuous physical activity without undue fatigue.

The PFI not only has tests to measure the strength of the back, legs, and grip, but also measures capacity for sustained physical activity with the pull-up and push-up tests. The vital capacity test is also included in the battery.

Test results may vary from day to day as does blood pressure, pulse, temperature, and other body measures. Nevertheless, physical fitness as measured by the PFI remained so constant that reliability coefficients of correlation from .86 to .97 were yielded in tests taken six months apart (9). When individuals were tested from 9:00 a.m. to 12:00 a.m. and 1:30 p.m. to 5:00 p.m., fluctuation for PFI was about five per cent, which is within the reliability limits (54).

Every bodily and mental change is reflected somehow, and to some degree in effective voluntary muscle power. Hundreds of cases on record exist in which low or declining PFIs have indicated the presence of disturbances to health which escaped recognition by competent physicians. The PFI

can provide an additional check on the physical condition of students since it may often reveal muscular strengths or weaknesses before subjective changes can be noted.

The PFI test was used because it is not only a rapid and interesting test, but also because it is a valid and reliable measure of physical fitness.

Testing Procedure

The following procedure was utilized in administering the Rogers' Physical Fitness Index.

Upon arriving at the testing center in the men's gymnasium the subject was given a PFI score sheet. Next his weight and height were measured. From here he proceeded with the PFI battery as prescribed by Larson and Yocum (4). The order of test items was as follows: lung capacity, right and left hand grip, back strength, leg strength, pull-ups, and push-ups after a five-minute rest. The score sheet was turned in and checked so that everything was completed. Total time for the administration of the PFI for each subject ranged from six to ten minutes.

Lung capacity. When arriving at the wet spirometer (standard Narragansett model), the subject inserted a sterile wooden mouthpiece into the spirometer hose. He was then instructed to inhale deeply and exhale all the air under his control slowly and steadily into a hose while

while bending forward. By cupping the hands around the mouthpiece and pinching his nostrils, the air was prevented from escaping. If the first test was inadequate the subject was given another trial. Lung capacity was recorded in cubic inches. This test item has a .97 reliability coefficient (9).

Grip strength. A hand dynamometer (Nissen Medart) was placed face down into the subject's palm so that the convex edge was rounded against the base of the hand, with the thumb touching or overlapping the first finger. The subject fixed his elbow so that his hand was near his ear. Then he was instructed to squeeze the dynamometer as he made a sweeping downward motion with his hand. The hand was not allowed to touch the body. Each hand was measured and recorded to the nearest pound. The left grip has a .90 reliability coefficient compared to .92 for the right hand (9).

Back lift. The subject was instructed to stand with his hands in front of his thighs, fingers extended downward with the feet parallel and six inches apart on a thirteen-inch bench to which a dynamometer (Medart No. 57021) was attached. The tester hooked a bar just below the subject's fingertips. The subject grasped the bar firmly at its ends with the thumb clenching the fingers and with one palm forward and the other backward. His back was slightly bent

at the beginning so it could not be completely straightened out on the lift. The subject's knees were not allowed to bend during the lift. The lift was recorded to the nearest pound. The test item has a .88 coefficient of reliability (9).

Leg lift. A lifting belt (3 inches wide, 60 inches long, one-fifth inch thick) was placed around the subject as low as possible over the hips and gluteal muscles. A permanent loop at one end of the belt was slipped over the end of the twenty-inch lifting bar and the free end was looped around the opposite end of the bar and tucked under and against the body. The subject was instructed to hold the lifting bar with both hands near the center against the junction of the thighs and trunk. In the starting position the knees were slightly bent, arms kept straight, head erect, and chest out. The maximum lift as measured by the dynamometer occurred when the subject's legs were nearly straightened. The lift was recorded to the nearest pound. The test item has a .86 coefficient of reliability (9).

Pull-ups. Still rings (Nissen) were adjusted so that the tallest subject was able to hang without touching the floor with his feet. The subject grasped the rings with his palms forward and chinmed as many times as possible. If the subject kicked, jerked, kipped, or did not complete

the pull-up he was awarded half a point. After four half points the subject was not allowed to continue. The number of repetitions was recorded as the total score. This test has a .91 reliability coefficient (9). A five-minute rest period was allowed between pull-ups and push-ups.

Push-ups. Regulation Nissen gymnasium parallel bars were adjusted to the subject's shoulder height. The subject grasped the bars and jumped to a straight arm support. This counted as one point. Each time the body was lowered until the upper arm and forearm were at less than a right angle and extended so the subject was again in a straight arm position a point was awarded. If a push-up was incomplete, half a point was awarded. A maximum of four half points could be awarded after which the subject was not allowed to continue. The total number of repetitions was the subject's score. The test has a .90 reliability coefficient (9).

Testers

The PFI test was administered by physical education majors, minors, and graduate students. Before they tested the freshman students, they were thoroughly instructed by the author in the proper procedures first by taking the test themselves, and then by trying it on other testers. Only when these students demonstrated competence were they

allowed to administer a particular test item.

Scoring the PFI

The following scoring procedures were used as prescribed by Larson and Yocum (4).

1. Score representing arm strength was computed according to the following formula:

$$(\text{Number of pull-ups} + \text{push-ups}) \left(\frac{\text{Weight} + \text{Height} - 60}{10} \right)$$

Fractions were rounded off to the nearest whole number.

2. Scores from each test item, lung capacity, right grip, left grip, back lift, leg lift, and arm strength score were added together. The total score is called the Strength Index.

3. The subject's norm strength index was obtained from the norm charts based on sex, weight, and age.

4. The PFI is computed from the formula:

$$\text{PFI} = \frac{\text{Achieved Strength Index}}{\text{Normal Strength Index}} \times 100$$

III. ACADEMIC ACHIEVEMENT

Academic achievement for the purpose of this study was determined by the cumulative academic index for the 1968-69 fall and winter quarters. This information was provided by the University of Montana registrar's office. The index of a student is the ratio of quality points to

his total number of hours attempted. Quality points are determined by the following: grade A is credited with 4 points; grade B, with 3; grade C, with 2; and grade D, with 1 point; and grade F, with zero.

IV. TREATMENT OF DATA

The PFI scores of each student were calculated at the University Computer Science Center on an IBM 1620 computer. Total PFI scores were then related to grade point averages with the Pearson product-moment correlation technique, as described by Willgoose (13).

In addition, the following physical variables were compared to GPA: height, weight, lung capacity, right grip, left grip, back lift, leg lift, pull-ups, push-ups, and strength index. Moreover, the Pearson product-moment method was used to compare PFI scores and GPA to the number of credits completed.

To determine if differences existed between the means of the freshman students in the College of Arts and Sciences and those in the professional schools, and students without a major, a one-way analysis of variance was used as described by Edwards (1).

CHAPTER IV

ANALYSIS OF DATA

I. RELATIONSHIP OF TOTAL PFI TO GPA

The 108 male freshmen used in this study had Physical Fitness Indices ranging from 49.5 to 125.3 with an 80.4 mean score. Rogers (9) suggested that the score of 100 should be the average. The low scores could be due to a lack of physical fitness activities in the physical education program at the University of Montana. Perhaps it was because of the lack of participation in physical activities or the type of high school physical education program the freshmen had prior to entering the university. When the PFI norms were developed in 1925 the average height and weight was less than that of students today. Therefore, the variables that could influence the PFI scores were numerous and it was not the purpose of this investigation to determine the cause of the low scores.

In this sample the cumulative academic indices ranged from 1.08 to 3.90 with a 2.38 mean.

To determine if a correlation existed between the Physical Fitness Index and grade point average, the two scores were compared with the Pearson r method of correlation. An r of .01106 was found which indicates no relationship between PFI and GPA.

II. RELATIONSHIP OF INDIVIDUAL PFI ITEMS TO GPA

In order to determine if any of the individual items of the PFI test correlated to GPA, the Pearson r method was used. Each PFI item was also analyzed for range and mean. Table I lists the ranges and means of PFI items. Refer to Table II for correlation of PFI items to GPA.

TABLE I
RANGE AND MEAN OF PFI ITEMS

PFI Item	Range	Mean
Height	61 inches to 77 inches	70.25
Back Lift	190 lbs. to 499 lbs.	328.7
Weight	130 lbs. to 237 lbs.	164.3
Leg Lift	320 lbs. to 1690 lbs.	847.1
Lung Capacity	185 cubic inches to 365 cubic inches	278.9
Pull-ups	1 to 20 repetitions	9.59
Right Grip	78 lbs. to 195 lbs.	124.9
Push-ups	0 to 35 repetitions	14.1
Left Grip	72 lbs. to 160 lbs.	115.8
TOTAL STRENGTH INDEX	1403 to 3741 points	2289.2

TABLE II
CORRELATION OF PFI ITEMS TO GPA

PFI Item	Pearson r Correlation to GPA
Height	-.0761
Weight	-.0206
Lung Capacity	-.0013
Right Grip	-.0082
Left Grip	-.0601
Back Lift	-.0948
Leg Lift	-.0165
Pull-ups	.0785
Push-ups	.0881
Strength Index	-.017

No correlation was significant at the .05 level between PFI and GPA.

III. RELATIONSHIP OF NUMBER OF HOURS ATTEMPTED TO GPA AND PFI

The attempted credit hours ranging from twenty-one to thirty-seven were compared to GPA and PFI scores. A .5284 correlation between the number of quarter credits attempted and GPA significant at the .05 and the .01 level was found. This indicates that students with a high GPA attempted more quarter credits at the University of Montana

than those with a low GPA. Freshmen generally enroll in fifteen quarter hours. In order for a student to enroll in credit hours exceeding seventeen, a signature from the advisor, chairman, or dean is needed. Freshman students with low ACT (American College Testing) scores may be limited to twelve or thirteen by their advisor. Since students are somewhat limited to the number of quarter hours they may attempt this could influence the correlation.

No correlation was found between the number of quarter hours attempted and PFI scores.

IV. RELATIONSHIP OF PFI SCORES TO FRESHMEN WITH OR WITHOUT MAJOR

During the freshman year many students select major areas of study that are included in the College of Arts and Sciences and the professional schools. The subjects in this study from the College of Arts and Sciences had an 81.08 mean PFI and majored in anthropology, biological sciences, chemistry, economics, English, history, liberal arts, mathematics, medical technology, physical therapy, political science, pre-business administration, pre-forestry, pre-medical sciences, sociology and wildlife biology.

The students from the professional schools had a 78.13 mean PFI and majored in drama, elementary education, forestry, journalism, music, and pharmacy.

The students who had not selected a major had a mean PFI of 83.64. The means of the three groups were then compared with Duncan's new multiple range test.

TABLE III
COMPARISONS BETWEEN PFI MEANS OF
GROUPS WITH AND WITHOUT MAJORS

	Non-Majors	College of Arts and Sciences	Professional Schools
Non-Majors	---	2.56	5.61**
College of Arts and Sciences	---	---	2.95*
Professional Schools	---	---	---

* Significant at the .05 level.

** Significant at the .01 level.

Non-majors, who had the highest PFI mean scores, were significantly superior to freshman students of professional schools, and freshmen in the College of Arts and Sciences were superior to the students in the professional schools.

V. DISCUSSION OF DATA

The results of this study show that there was no relationship between the PFI and GPA of 108 male freshman students enrolled in physical education activity classes at the University of Montana. Even when individual items of

the PFI were compared to GPA, no relationship was found. This concurs with the results found by Ricci (52), who studied 895 freshmen at the University of Massachusetts and found no significant relationship between PFI and GPA.

However, most studies mentioned in the review of literature have found a low positive significant correlation between PFI and GPA. These studies were not identical to the one conducted by the author. Page (71), Coefield and McCollum (22), and Doornick (25) used all the male freshmen as their sample and tested in the fall. Hart and Shay (30), Wilson (68), and Weber (67), also tested in the fall. In this study, testing was done in the spring. This does not mean that the testing results would have been significantly altered according to Rogers (9). However, if the freshman students were physically active in the summer, they might be well conditioned in the fall. Due to the demands created by the university environment the level of physical condition could be changed by spring.

The sample was obtained from a group of more than 450 freshmen enrolled in activity classes. Had an appropriate sample in terms of randomness and representativeness of the total male freshman class participated, the results might have differed. Additionally, this study might have included those freshmen enrolled in certain activity classes to eliminate the effects of the activity on the PFI scores.

Activities such as physical conditioning and weight lifting will have a significant effect on the PFI scores. This might indicate a need for developing more stable measures of physical fitness. With a little effort, PFI scores can be improved, just as grade point average can be changed. In addition, perhaps a more stable index of academic achievement, which measures intelligence, should be used.

From this investigation and research cited in the literature, it is rather questionable whether future studies should be continued in the area of physical and mental relationships. The attempts have been so confounded with variables it may be impossible to partition those variables that may be related. If any factor needs to be partitioned, perhaps it is the characteristic of persistence. Persistence to endure a task until it is completed might be the factor which is developed through physical fitness. If a physically fit individual is able to endure physical strain for a longer period than one who is physically unfit, perhaps this persistence carries over to mental tasks. If, however, it is impossible to partition this variable or others that may have an effect upon mental tasks, then these studies should be discontinued.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

The purpose of this study was to determine the relationship between academic achievement and physical fitness of University of Montana male freshmen with at least twenty credit hours.

The measures used in this study were the Rogers' PFI, the cumulative academic index, and the total number of credits earned.

The subjects were 108 freshmen enrolled in activity classes at the University of Montana. Correlations between the Physical Fitness Index and cumulative academic indices .011, between the Physical Fitness Index and number of credits earned .079 were not significant at the .05 level of confidence. An r of .5289 was found between the cumulative academic index and the number of credits earned at the .05 and the .001 level of significance. Students classified as non-majors had significantly higher PFI scores (83.64) than students from the professional schools (78.13); and majors in the college of Arts and Sciences also had significantly higher PFI scores (81.08) than the majors in the professional schools.

II. CONCLUSIONS

An analysis of the results in this study reveals the following conclusions:

1. Students with high physical fitness indices do not have high academic indices.
2. Students classified as non-majors are superior in physical fitness indices to student majors in the professional schools, but not to those in the College of Arts and Sciences.
3. Students majoring in the College of Arts and Sciences are superior in physical fitness indices to the students in the professional schools.
4. Students who have high cumulative academic indices also have completed more quarter credit hours than students with low cumulative academic indices.

III. RECOMMENDATIONS

It is recommended that the psychological and sociological benefits of physical fitness be partitioned and related to academic achievement. If, however, further research indicates that these qualities can not be partitioned, it is recommended that studies relating the physiological benefits to academic achievement be discontinued.

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APPENDIX A

7

TO: ALL MEN'S ACTIVITY CLASS INSTRUCTORS
FROM: VINCE CELTNIEKS
RE: ROGERS' PHYSICAL FITNESS INDEX TEST
TO BE ADMINISTERED TO ALL FALL 1968 FRESHMAN
ENROLLEES ON WEDNESDAY, MAY 7, IN THE MEN'S
GYM.

The study I am conducting involves the relationship of physical fitness to academic achievement. All male freshmen who have enrolled at the U of M since fall 1968 and are not in activity classes comprise my sample. Therefore, I am soliciting your cooperation. Please send your freshman students to the men's gym at your regular class time on Wednesday, May 7.

THANK YOU

VINCE CELTNIEKS

PHYSICAL FITNESS INDEX

ROGERS STRENGTH TEST

Name _____ Telephone _____

Date Enrolled at U of M _____

Y M

Age	Years and whole months
Weight	Nearest pound
Height	Nearest inch
Multiplier	$\frac{\text{Weight} + \text{Height} - 60}{10}$
Pull-ups	Total number
Push-ups	Total number
Arm Strength	Pull-ups + push-ups x Multiplier
Leg Lift	Nearest pound
Back Lift	Nearest pound
Left Grip	Nearest pound
Right Grip	Nearest pound
Lung Capacity	Cubic inches
Strength Index	Total from arm strength through lung capacity.
Normal Strength Index	Normal Strength Index: Find norm in tables for age, sex, and weight. If weight is an odd number use nearest even number in weight column. Record the figure from table as normal strength index.
Physical Fitness Index	

A freshman student taking this test must be a fall 1968 enrollee, having attended the winter quarter at the U of M and not having transferred from another college.

APPENDIX B
PFI INDIVIDUAL ITEMS AND GPA

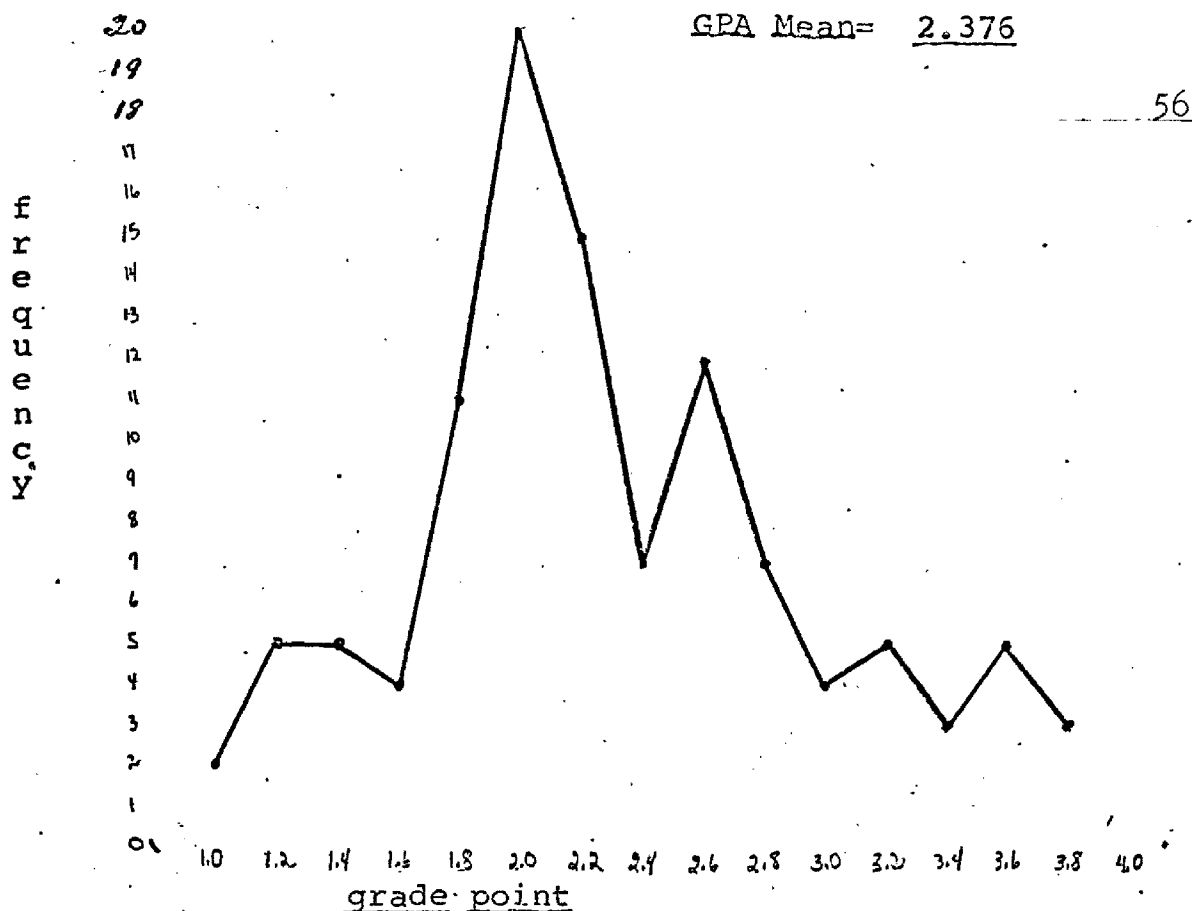
	FFI	GPA	Age	Wt.	Ht.	PL	PS	LL	BL	GL	GR	LC	NI
EDJ	49.5	2.04	20.	173.	70.	3.5	6.	550.	250.	100.	120.	275.	3138
EP	51.1	2.83	19.	155.	69.	9.5	0.	390.	310.	120.	132.	280.	2746
PM	53.4	2.90	19.	237.	69.	1.	2.5	1170.	440.	155.	170.	294.	4385
TEG	55.6	3.65	18.	190.	73.	2.5	3.	860.	230.	130.	127.	250.	3266
EM	56.5	1.73	20.	185.	77.	4.5	5.5	540.	380.	139.	137.	365.	3389
DAL	56.7	2.17	19.	171.	70.	3.	4.	750.	330.	110.	113.	255.	3079
LS	58.8	1.95	19.	151.5	71.	5.	4.5	650.	250.	123.	93.	260.	2787
HL	59.2	2.03	19.	168.	68.	4.5	12.	550.	300.	115.	110.	290.	2996
TT	59.3	2.24	19.	175.	71.	5.	8.	530.	433.	119.	138.	285.	3162
RSI	61.8	2.66	19.	168.	76.	6.	2.	450.	350.	90.	130.	340.	2996
KLN	62.3	3.65	19.	167.	72.	6.	5.5	800.	250.	110.	110.	268.	2996
DAS	63.5	3.00	18.	152.	71.	3.5	6.	640.	250.	90.	120.	290.	2580
EOJ	66.0	2.16	19.	148.	71.	7.5	6.5	650.	200.	90.	95.	230.	2579
JF	66.4	2.03	18.	180.	73.	8.	7.5	800.	330.	110.	120.	260.	3159
JL	66.6	1.62	19.	209.	72.	2.5	11.5	1130.	340.	140.	150.	298.	3779
BF	67.3	1.21	18.	186.	73.	6.	6.	920.	340.	133.	133.	305.	3283
JES	68.7	2.87	19.	167.	70.	9.	12.	700.	300.	109.	130.	260.	2996
RS	68.9	2.53	19.	140.	70.	4.5	10.5	450.	260.	125.	120.	294.	2332
EM	69.3	2.72	19.	166.	59.	6.	6.5	900.	350.	98.	130.	250.	2954
ERR	69.7	2.19	19.	205.	73.	6.5	12.	1120.	380.	120.	140.	260.	3787
JLS	69.9	2.53	19.	147.	68.	9.	7.	750.	250.	86.	110.	245.	2575
EMH	70.7	3.76	18.	155.	69.	5.5	8.5	790.	290.	110.	110.	240.	2663
GES	71.0	3.34	17.	154.	65.	12.	22.5	350.	250.	110.	120.	250.	2575
EDJ	71.0	3.42	19.	183.	72.	6.5	13.5	870.	370.	110.	120.	290.	3329
LL	71.0	2.36	19.	189.	72.	2.	15.	950.	320.	130.	145.	320.	3363
CAM	71.1	2.36	19.	146.	68.	12.	17.5	350.	250.	105.	115.	220.	2538
RLG	71.2	3.16	19.	179.	75.	6.	6.5	1000.	320.	138.	140.	304.	3248
JE	71.7	2.51	18.	131.	71.	3.	7.5	600.	290.	98.	103.	210.	2167
DRW	71.7	3.52	21.	214.	75.	9.5	16.	950.	380.	128.	138.	354.	3987
PR	72.0	1.88	20.	191.	71.	4.	7.	1100.	360.	142.	139.	315.	3311
JG	72.1	2.37	19.	194.	69.	6.	12.	900.	500.	135.	125.	305.	3441
RJK	72.2	3.41	18.	172.	68.	7.	15.5	730.	310.	130.	125.	300.	2994
JLD	72.5	1.52	19.	179.	73.	11.	11.5	800.	310.	110.	117.	250.	3150
DJD	73.1	1.80	19.	148.	68.	10.5	6.5	735.	310.	72.	83.	300.	2574
GL	73.1	1.38	19.	166.	71.	7.5	11.5	850.	320.	110.	115.	240.	2950
CW	73.6	1.88	18.	151.	61.	17.	31.	230.	430.	100.	93.	275.	258
KWH	74.0	3.84	19.	147.	68.	12.	20.5	520.	190.	100.	99.	265.	2571
RM	74.5	1.57	20.	175.	74.	6.	10.5	950.	350.	130.	140.	280.	318
ERM	75.0	2.69	19.	183.	73.	6.5	14.	950.	350.	123.	130.	304.	332
WHS	75.6	1.96	19.	173.	70.	5.	16.5	920.	275.	115.	130.	270.	303
GLB	76.0	1.03	19.	156.	67.	10.5	12.5	720.	320.	112.	82.	335.	274
MPS	76.1	2.03	19.	148.	70.	10.	11.	700.	300.	95.	90.	258.	257
CBS	76.6	2.12	19.	173.	71.	5.	11.5	1020.	310.	110.	120.	300.	303
GL	77.0	2.83	19.	150.	69.	10.	16.5	640.	240.	120.	114.	270.	262
AJK	77.1	2.76	18.	166.	68.	8.	17.	710.	360.	132.	138.	260.	287
GAB	77.2	1.79	19.	136.	68.	8.	9.	610.	310.	81.	100.	270.	224
DW	77.9	1.79	19.	156.	72.	6.	8.5	870.	350.	110.	122.	275.	274
EW	78.0	2.11	19.	154.	69.	9.5	14.	710.	300.	135.	138.	255.	270
CM	78.1	1.27	22.	201.	72.	10.	18.5	1000.	400.	160.	140.	260.	372
HS	78.5	2.09	18.	150.	72.	11.	12.5	530.	255.	130.	120.	324.	253
PD	80.8	2.83	20.	139.	66.	5.	11.	600.	300.	90.	100.	206.	242
KLN	78.8	1.92	19.	174.	70.	9.	18.5	890.	270.	112.	124.	322.	312
EMS	80.2	2.15	19.	142.	65.	15.	10.	580.	300.	122.	130.	185.	245
NP	80.6	1.80	19.	184.	71.	8.	15.	1000.	370.	160.	160.	320.	332
LSP	80.8	2.71	19.	162.	66.	15.5	18.5	750.	300.	125.	130.	262.	287
DB	80.9	2.93	19.	162.	73.	9.5	9.5	640.	300.	100.	110.	320.	287
			18.	136.	70.	7.	15.5	500.	300.	109.	130.	265.	220
			19.	167.	71.	11.	16.5	745.	345.	140.	140.	312.	290
			19.	160.	72.	11.	11.	820.	350.	120.	108.	300.	283
			19.	162.	69.	12.5	14.5	800.	350.	110.	120.	290.	287
			19.	160.	66.	9.	14.	825.	360.	130.	155.	274.	274
			19.	167.	60.	9.	7.	870.	380.	100.	125.	200.	245

	PFI	GPA	Age	Wt.	Ht.	PL	PS	LL	BL	GL	GR	LC	NL
EB	82.5	1.21	19.	135.	67.	9.5	19.5	770.	200.	70.	75.	220.	251
JC	82.9	1.59	20.	172.	74.	6.	12.5	1050.	320.	130.	150.	340.	3004
CE	83.2	1.85	19.	189.	72.	13.	14.5	1100.	345.	120.	120.	342.	3454
LT	83.3	3.00	19.	150.	69.	11.	28.	420.	360.	110.	128.	230.	2631
KJD	83.5	2.80	19.	176.	71.	18.	22.5	670.	350.	130.	120.	214.	3162
GCH	84.1	3.23	19.	143.	72.	9.5	12.	770.	310.	80.	90.	284.	2406
EH	84.8	1.30	19.	166.	69.	8.	13.	610.	405.	135.	140.	290.	2652
TL	84.9	2.24	19.	161.	66.	5.5	8.	1220.	270.	105.	138.	235.	2787
TK	85.1	3.72	19.	159.	72.	9.	18.	705.	350.	128.	125.	348.	2829
JAL	85.2	2.32	19.	168.	70.	10.	12.	1000.	350.	160.	150.	232.	2911
EEB	85.4	1.11	18.	175.	70.	6.	14.5	1200.	300.	115.	135.	315.	3077
DEM	85.7	2.61	19.	148.	67.	6.5	11.5	970.	350.	91.	117.	290.	2579
LH	85.7	3.33	18.	166.	68.	10.	15.	990.	370.	102.	130.	265.	2870
GB	85.8	1.86	18.	182.	75.	10.5	10.5	1120.	340.	115.	130.	345.	3201
DMD	86.1	1.43	18.	149.	72.	11.	19.5	600.	300.	90.	103.	275.	2539
RBD	86.8	2.25	19.	152.	68.	10.5	16.5	850.	290.	117.	132.	225.	2580
TJS	86.9	3.84	19.	167.	68.	13.	18.	900.	340.	110.	120.	295.	2911
FM	87.5	3.19	19.	158.	70.	10.	11.5	1045.	295.	130.	135.	282.	2788
SP	88.6	2.51	18.	178.	72.	9.5	26.	760.	400.	130.	140.	275.	3110
FAL	88.8	2.03	19.	170.	72.	9.	18.	940.	410.	130.	130.	305.	3037
BN	88.8	3.42	18.	178.	70.	5.5	20.	1120.	380.	111.	140.	310.	3118
CLP	90.2	2.09	19.	175.	69.	9.	14.	1200.	443.	140.	150.	310.	3162
EAV	90.3	2.04	19.	182.	70.	5.	10.5	1690.	320.	130.	122.	270.	3257
RS	91.9	2.17	19.	169.	71.	7.	12.5	1330.	310.	110.	138.	284.	2953
KT	92.0	1.59	18.	151.	73.	7.5	13.	900.	380.	125.	125.	270.	2580
JDK	92.1	2.03	19.	178.	72.	9.5	19.5	1200.	200.	110.	140.	258.	3118
ND	92.3	2.00	19.	172.	71.	8.5	20.5	1050.	400.	115.	130.	330.	3079
JC	92.5	2.38	18.	205.	74.	8.	19.5	1433.	400.	130.	195.	316.	3697
WAT	93.2	3.37	18.	148.	68.	10.	14.5	990.	320.	100.	95.	266.	2498
MGR	95.2	2.43	18.	147.	67.	12.5	20.5	800.	350.	118.	125.	270.	2498
GAP	95.6	2.00	19.	130.	66.	14.	22.5	600.	280.	110.	110.	238.	2125
BWM	96.5	2.24	18.	127.	68.	15.	17.	825.	350.	80.	95.	244.	2371
RP	96.5	2.11	18.	148.	72.	12.5	21.	650.	350.	110.	128.	240.	2409
CZ	96.6	2.32	18.	150.	67.	9.	16.5	1100.	290.	105.	120.	270.	2539
KEH	97.7	3.00	19.	156.	72.	12.5	17.5	900.	420.	120.	130.	285.	2746
SJ	98.5	1.89	19.	154.	72.	11.	14.5	1050.	340.	115.	140.	322.	2704
RK	98.9	2.37	19.	167.	71.	12.5	14.5	1300.	310.	130.	130.	348.	2998
HLD	99.8	2.76	18.	134.	70.	13.	18.	620.	330.	130.	110.	290.	2208
BGT	100.3	2.51	19.	147.	70.	9.	13.5	520.	210.	80.	78.	285.	1723
DP	100.3	2.76	18.	165.	74.	14.5	17.5	1120.	320.	110.	150.	303.	2954
WEJ	101.7	2.68	18.	138.	72.	4.5	12.	565.	250.	98.	120.	250.	1679
RFR	104.0	2.00	18.	174.	75.	7.	25.	1100.	400.	141.	154.	325.	3035
JVL	105.1	2.30	19.	154.	68.	9.	24.5	1140.	450.	110.	110.	250.	2704
DM	107.3	2.76	19.	130.	64.	12.	25.	970.	310.	110.	120.	210.	2205
NAL	113.4	3.90	18.	184.	72.	20.	35.	1040.	370.	157.	153.	350.	3242
BJB	125.3	2.21	19.	142.	68.	18.5	32.5	1100.	390.	120.	135.	200.	2454

APPENDIX C
PFI AND GPA FREQUENCY CHARTS

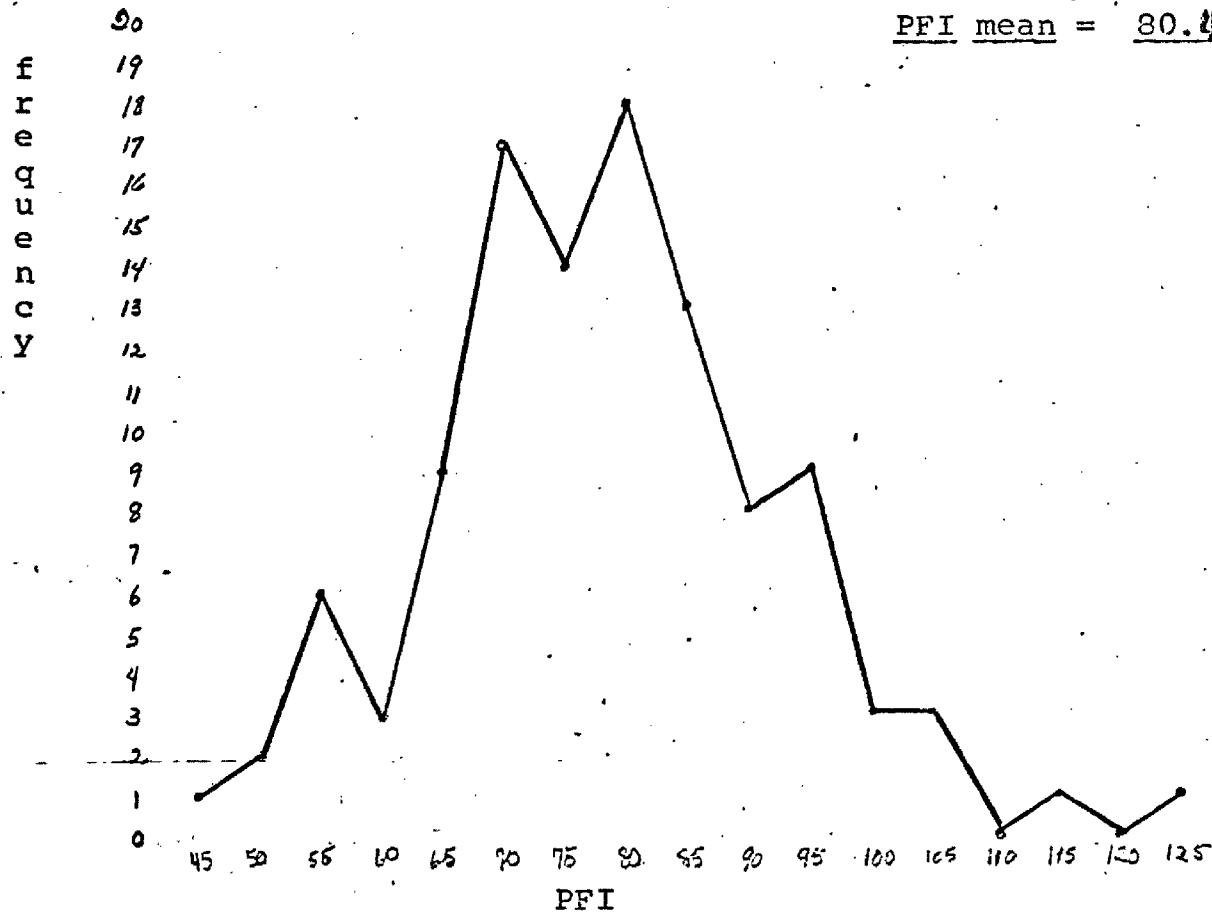
Graph I.: Grade Point Average of 108 Freshmen

GPA Mean= 2.376



Graph II.: Physical Fitness Index of 108 Freshmen

PFI mean = 80.4



APPENDIX D
COMPUTATION OF DATA

PEARSON PRODUCT MOMENT CORRELATION COMPUTATION

$$N = 108$$

X (measures) Height

Y (measures) GPA

$$\sum fx = 27$$

$$\sum fy = 59$$

$$\sum fx^2 = 775$$

$$\sum fy^2 = 1229$$

$$\sum xy = -54$$

$$c_x = \frac{\sum fx}{N} = \frac{27}{108} = .25 \quad c_x^2 = .0625$$

$$c_y = \frac{\sum fy}{N} = \frac{59}{108} = .546 \quad c_y^2 = .298$$

$$\sigma'_x = \sqrt{\frac{\sum fx^2}{N} - c_x^2} = \sqrt{\frac{775}{108} - .0625} = \sqrt{7.1134} = 2.667$$

$$\sigma'_y = \sqrt{\frac{\sum fy^2}{N} - c_y^2} = \sqrt{\frac{1229}{108} - .298} = \sqrt{11.08} = 3.33$$

$$\sigma_x = (\sigma'_x) (S. I. _x) = (2.667) (1) = 2.667$$

$$\sigma_y = (\sigma'_y) (S. I. _y) = (3.33) (.2) = .666$$

$$r = \frac{\frac{\sum xy}{N} - (c_x)(c_y)}{(\sigma'_x)(\sigma'_y)} = \frac{\frac{-54}{108} - (.25)(.546)}{(2.667)(3.33)}$$

$$= \frac{-.54 - .1365}{8.88} = \frac{-.6765}{8.88} = \boxed{-.0761}$$

PEARSON PRODUCT MOMENT CORRELATION COMPUTATION

$$N = 108$$

X (measures) Weight

Y (measures) GPA

$$\sum fx = -14$$

$$\sum fy = 59$$

$$\sum fx^2 = 412$$

$$\sum fy^2 = 1229$$

$$\sum xy = -19$$

$$c_x = \frac{\sum fx}{N} = \frac{-14}{108} = -.12 \quad c_x^2 = .0144$$

$$c_y = \frac{\sum fy}{N} = \frac{59}{108} = .546 \quad c_y^2 = .298$$

$$\sigma'_x = \sqrt{\frac{\sum fx^2}{N} - c_x^2} = \sqrt{\frac{412}{108} - .0144} = \sqrt{3.7966} = 1.948$$

$$\sigma'_y = \sqrt{\frac{\sum fy^2}{N} - c_y^2} = \sqrt{\frac{1229}{108} - .298} = \sqrt{11.08} = 3.33$$

$$\sigma_x = (\sigma'_x) (S. I. x) = (1.948) (10) = 19.48$$

$$\sigma_y = (\sigma'_y) (S. I. y) = (3.33) (.2) = .666$$

$$r = \frac{\frac{\sum xy}{N} - (c_x)(c_y)}{(\sigma'_x)(\sigma'_y)} = \frac{\frac{-19}{108} - (-.12)(.298)}{(1.948)(3.33)}$$

$$= \frac{-.17 + .036}{6.48684} = \frac{-.134}{6.487} = \boxed{-.0206}$$

PEARSON PRODUCT MOMENT CORRELATION COMPUTATION

60

$$N = 108$$

X (measures) Lung Capacity y (measures) GPA

$$\sum fx = 78$$

$$\sum fy = 59$$

$$\sum fx^2 = 1564$$

$$\sum fy^2 = 1229$$

$$\sum xy = 25$$

$$c_x = \frac{\sum fx}{N} = \frac{78}{108} = .722 \quad c_x^2 = .521$$

$$c_y = \frac{\sum fy}{N} = \frac{59}{108} = .546 \quad c_y^2 = .298$$

$$\sigma'_x = \sqrt{\frac{\sum fx^2}{N} - c_x^2} = \sqrt{\frac{1564}{108} - .521} = \sqrt{13.960} = 3.74$$

$$\sigma'_y = \sqrt{\frac{\sum fy^2}{N} - c_y^2} = \sqrt{\frac{1229}{108} - .298} = \sqrt{11.082} = 3.33$$

$$\sigma_x = (\sigma'_x) (S. I. x) = (3.74) (10) = 37.4$$

$$\sigma_y = (\sigma'_y) (S. I. y) = (3.33) (.2) = .666$$

$$r = \frac{\frac{\sum xy}{N} - (c_x)(c_y)}{(\sigma'_x)(\sigma'_y)} = \frac{\frac{25}{108} - (.722)(.546)}{(3.74)(3.33)}$$

$$= \frac{.231 - .394}{124.54} = \frac{-.163}{124.54} = -.0013$$

$$N = 108$$

X (measures) Right Grip Y (measures) GPA

$$\sum fx = 27$$

$$\sum fy = 59$$

$$\sum fx^2 = 407$$

$$\sum fy^2 = 1229$$

$$\sum xy = 9$$

$$c_x = \frac{\sum fx}{N} = \frac{27}{108} = .25; \quad c_x^2 = .0625$$

$$c_y = \frac{\sum fy}{N} = \frac{59}{108} = .546; \quad c_y^2 = .298$$

$$\sigma'_x = \sqrt{\frac{\sum fx^2}{N} - c_x^2} = \sqrt{\frac{407}{108} - .0625} = \sqrt{3.748 - .0625} = \sqrt{3.6855} = 1.92$$

$$\sigma'_y = \sqrt{\frac{\sum fy^2}{N} - c_y^2} = \sqrt{\frac{1229}{108} - .298} = \sqrt{11.389 - .298} = \sqrt{11.091} = 3.33$$

$$\sigma_x = (\sigma'_x) (S. I. _x) = (1.92) (.1) = .192$$

$$\sigma_y = (\sigma'_y) (S. I. _y) = (3.33) (.2) = .666$$

$$r = \frac{\frac{\sum xy}{N} - (c_x)(c_y)}{(\sigma'_x)(\sigma'_y)} = \frac{\frac{9}{108} - (.25)(.546)}{(1.92)(3.33)}$$

$$= \frac{.0833 - .1365}{6.3936} = \frac{-.053}{6.394} = \boxed{-.0082}$$

PEARSON PRODUCT MOMENT CORRELATION COMPUTATION

62

$$N = 108$$

X (measures) Left Grip Y (measures) GPA

$$\sum fx = 9$$

$$\sum fy = 59$$

$$\sum fx^2 = 1475$$

$$\sum fy^2 = 1229$$

$$\sum xy = -75$$

$$c_x = \frac{\sum fx}{N} = \frac{9}{108} = .083 : c_x^2 = .006889$$

$$c_y = \frac{\sum fy}{N} = \frac{59}{108} = .546 : c_y^2 = .298$$

$$\sigma'_x = \sqrt{\frac{\sum fx^2}{N} - c_x^2} = \sqrt{\frac{1475}{108} - .007} = \sqrt{13.65} = 3.694$$

$$\sigma'_y = \sqrt{\frac{\sum fy^2}{N} - c_y^2} = \sqrt{\frac{1229}{108} - .298} = \sqrt{11.08} = 3.33$$

$$\sigma_x = (\sigma'_x) (S. I. x) = (3.694) (5) = 18.47$$

$$\sigma_y = (\sigma'_y) (S. I. y) = (3.33) (.2) = .666$$

$$r = \frac{\frac{\sum xy}{N} - (c_x)(c_y)}{(\sigma'_x)(\sigma'_y)} = \frac{\frac{-75}{108} - (.083)(.546)}{(3.69)(3.33)}$$

$$= \frac{-.694 - .045}{12.288} = \frac{-.739}{12.288} = \boxed{-.060139}$$

PEARSON PRODUCT MOMENT CORRELATION COMPUTATION

63

$$N = 108$$

X (measures) Back Lift Y (measures) GPA

$$\sum fx = -17$$

$$\sum fy = 59$$

$$\sum fx^2 = 535$$

$$\sum fy^2 = 1229$$

$$\sum xy = -85$$

$$C_x = \frac{\sum fx}{N} = \frac{-17}{108} = -.1574 \quad C_x^2 = .0248$$

$$C_y = \frac{\sum fy}{N} = \frac{59}{108} = .5462 \quad C_y^2 = .298$$

$$\sigma'_x = \sqrt{\frac{\sum fx^2}{N} - C_x^2} = \sqrt{\frac{535}{108} - .0248} = \sqrt{4.93} = 2.22$$

$$\sigma'_y = \sqrt{\frac{\sum fy^2}{N} - C_y^2} = \sqrt{\frac{1229}{108} - .298} = \sqrt{11.08} = 3.33$$

$$\sigma_x = (\sigma'_x) (S. I. x) = (2.22) (.25) = .555$$

$$\sigma_y = (\sigma'_y) (S. I. y) = (3.33) (.2) = .666$$

$$r = \frac{\frac{\sum xy}{N} - (C_x)(C_y)}{(\sigma'_x)(\sigma'_y)} = \frac{\frac{-85}{108} + (.157)(.546)}{(2.22)(3.33)}$$

$$= \frac{-0.787 + 0.0857}{7.3926} = \frac{-0.7013}{7.3926} = \boxed{-.0948}$$

PEARSON PRODUCT MOMENT CORRELATION COMPUTATION

64

$$N = 108$$

X (measures) Leg Lift

Y (measures) GPA

$$\sum fx = 17$$

$$\sum fy = 59$$

$$\sum fx^2 = 679$$

$$\sum fy^2 = 1229$$

$$\sum xy = -139$$

$$c_x = \frac{\sum fx}{N} = \frac{17}{108} = .157 \quad c_x^2 = .0246$$

$$c_y = \frac{\sum fy}{N} = \frac{59}{108} = .546 \quad c_y^2 = .298$$

$$\sigma'_x = \sqrt{\frac{\sum fx^2}{N} - c_x^2} = \sqrt{\frac{679}{108} - .0246} = \sqrt{6.2624} = 2.5$$

$$\sigma'_y = \sqrt{\frac{\sum fy^2}{N} - c_y^2} = \sqrt{\frac{1229}{108} - .298} = \sqrt{11.082} = 3.33$$

$$\sigma_x = (\sigma'_x) (S. I. x) = (2.5) (100) = 250$$

$$\sigma_y = (\sigma'_y) (S. I. y) = (3.33) (.2) = .666$$

$$r = \frac{\sum xy}{N} - (c_x)(c_y) = \frac{-139}{108} - (.157)(.546)$$

$$= \frac{-(\sigma'_x)(\sigma'_y)}{(\sigma'_x)(\sigma'_y)} = \frac{(-2.5)(3.33)}{(2.5)(3.33)}$$

$$= \frac{-1.287 - .0857}{8.325} = \frac{-1.373}{8.327} = \boxed{-.0165}$$

$$N = 108$$

X (measures) Pull-ups

Y (measures) GPA

$$\sum fx = -46$$

$$\sum fy = 59$$

$$\sum fx^2 = 1472$$

$$\sum fy^2 = 1229$$

$$\sum xy = 80$$

$$c_x = \frac{\sum fx}{N} = \frac{-46}{108} = -.426 \quad c_x^2 = .181$$

$$c_y = \frac{\sum fy}{N} = \frac{59}{108} = .546 \quad c_y^2 = .298$$

$$\sigma'_x = \sqrt{\frac{\sum fx^2}{N} - c_x^2} = \sqrt{\frac{1472}{108} - .181} = \sqrt{13.558} = 3.68$$

$$\sigma'_y = \sqrt{\frac{\sum fy^2}{N} - c_y^2} = \sqrt{\frac{1229}{108} - .298} = \sqrt{11.08} = 3.33$$

$$\sigma_x = (\sigma'_x) (S. I. _x) = (3.68) (1) = 3.68$$

$$\sigma_y = (\sigma'_y) (S. I. _y) = (3.33) (.2) = .666$$

$$r = \frac{\frac{\sum xy}{N} - (c_x)(c_y)}{(\sigma'_x)(\sigma'_y)} = \frac{\frac{80}{108} - (-.426)(.546)}{(3.68)(3.33)}$$

$$= \frac{.741 + .232}{12.392} = \frac{.973}{12.392} = .0785$$

PEARSON PRODUCT MOMENT CORRELATION COMPUTATION

66

$$N = 108$$

X (measures) Push-Ups

Y (measures) GPA

$$\sum fx = -36$$

$$\sum fy = 59$$

$$\sum fx^2 = 1006$$

$$\sum fy^2 = 1229$$

$$\sum xy = 86$$

$$c_x = \frac{\sum fx}{N} = \frac{-36}{108} = -.333 \quad c_x^2 = .1108$$

$$c_y = \frac{\sum fy}{N} = \frac{59}{108} = .546 \quad c_y^2 = .298$$

$$\sigma'_x = \sqrt{\frac{\sum fx^2}{N} - c_x^2} = \sqrt{\frac{1006}{108} - .1108} = \sqrt{9.31} = 3.05$$

$$\sigma'_y = \sqrt{\frac{\sum fy^2}{N} - c_y^2} = \sqrt{\frac{1229}{108} - .298} = \sqrt{11.08} = 3.33$$

$$\sigma_x = (\sigma'_x) (S. I. _x) = (3.05) (.2) = 6.1$$

$$\sigma_y = (\sigma'_y) (S. I. _y) = (3.33) (.2) = .666$$

$$r = \frac{\frac{\sum xy}{N} - (c_x)(c_y)}{(\sigma'_x)(\sigma'_y)} = \frac{\frac{86}{108} - (.333)(.298)}{(3.05)(3.33)}$$

$$= \frac{.796 + .099}{10.1565} = \frac{.895}{10.1565} = .0881$$

$$N = 108$$

X (measures) Strength Index Y (measures) GPA

$$\sum fx = -22$$

$$\sum fy = 59$$

$$\sum fx^2 = 839$$

$$\sum fy^2 = 1229$$

$$\sum xy = -29$$

$$c_x = \frac{\sum fx}{N} = \frac{-22}{108} = -.2037 : c_x^2 = .0415$$

$$c_y = \frac{\sum fy}{N} = \frac{59}{108} = .546 : c_y^2 = .298$$

$$\sigma'_x = \sqrt{\frac{\sum fx^2}{N} - c_x^2} = \sqrt{\frac{839}{108} - .0415} = \sqrt{7.7177} = 2.778$$

$$\sigma'_y = \sqrt{\frac{\sum fy^2}{N} - c_y^2} = \sqrt{\frac{1229}{108} - .298} = \sqrt{11.08} = 3.33$$

$$\sigma_x = (\sigma'_x) (S. I. x) = (2.778) (150) = 416.7$$

$$\sigma_y = (\sigma'_y) (S. I. y) = (3.33) (.2) = .666$$

$$r = \frac{\frac{\sum xy}{N} - (c_x)(c_y)}{(\sigma'_x)(\sigma'_y)} = \frac{\frac{-29}{108} - (-.2037)(.546)}{(2.778)(3.33)}$$

$$= \frac{-.2655 + .1112}{9.2507} = \frac{-.1543}{9.2507} = \boxed{-.017}$$

$$N = 108$$

X (measures) PFI

Y (measures) GPA

$$\sum fx = -39$$

$$\sum fy = 56$$

$$\sum fx^2 = 843$$

$$\sum fy^2 = 1226$$

$$\sum xy = -9$$

$$c_x = \frac{\sum fx}{N} = \frac{-39}{108} = -.3611 \quad c_x^2 = .13039$$

$$c_y = \frac{\sum fy}{N} = \frac{56}{108} = .518518 \quad c_y^2 = .26886$$

$$\sigma'_x = \sqrt{\frac{\sum fx^2}{N} - c_x^2} = \sqrt{\frac{843}{108} - .13039} = \sqrt{7.9529} = 2.82$$

$$\sigma'_y = \sqrt{\frac{\sum fy^2}{N} - c_y^2} = \sqrt{\frac{1226}{108} - .26886} = \sqrt{11.08299} = 3.329$$

$$\sigma_x = (\sigma'_x) (S. I. _x) = (2.82) (.5) = 1.41$$

$$\sigma_y = (\sigma'_y) (S. I. _y) = (3.329) (.2) = .6658 = .666$$

$$r = \frac{\frac{\sum xy}{N} - (c_x)(c_y)}{(\sigma'_x)(\sigma'_y)} = \frac{\frac{-9}{108} - (.3611)(.5185)}{(2.82)(3.329)}$$

$$= \frac{-.8333 + .18723}{9.388} = \frac{-.1039}{9.388} = \boxed{.01106}$$

PEARSON PRODUCT MOMENT CORRELATION COMPUTATION

$$N = 108$$

X (measures) Total Number Credits Y (measures) GPA

$$\sum fx = -96$$

$$\sum fy = 63$$

$$\sum fx^2 = 1978$$

$$\sum fy^2 = 1285$$

$$\sum xy = 757$$

$$C_x = \frac{\sum fx}{N} = \frac{-96}{108} = -.889 \quad C_x^2 = .790$$

$$C_y = \frac{\sum fy}{N} = \frac{63}{108} = .583 \quad C_y^2 = .3398$$

$$\sigma'_x = \sqrt{\frac{\sum fx^2}{N} - C_x^2} = \sqrt{\frac{1978}{108} - .79} = \sqrt{18.31 - .79} = 4.185$$

$$\sigma'_y = \sqrt{\frac{\sum fy^2}{N} - C_y^2} = \sqrt{\frac{1285}{108} - .34} = \sqrt{11.90 - .34} = 3.4$$

$$\sigma_x = (\sigma'_x) (S. I. x) = (4.185) (1) = 4.18$$

$$\sigma_y = (\sigma'_y) (S. I. y) = (3.4) (.2) = .68$$

$$r = \frac{\frac{\sum xy}{N} - (C_x)(C_y)}{(\sigma'_x)(\sigma'_y)} = \frac{7.009 - (-.889)(.583)}{(4.185)(3.4)}$$

$$= \frac{7.009 + .518}{14.23} = \frac{7.527}{14.23} = .5289$$

$$N = 108$$

X (measures) Total Number Credits Y (measures) P.F.I.

$$\sum fx = -96$$

$$\sum fy = -37$$

$$\sum fx^2 = 1610$$

$$\sum fy^2 = 861$$

$$\sum xy = 134$$

$$c_x = \frac{\sum fx}{N} = \frac{-96}{108} = -.889 \quad c_x^2 = .79$$

$$c_y = \frac{\sum fy}{N} = \frac{-37}{108} = -.3426 \quad c_y^2 = .1174$$

$$\sigma'_x = \sqrt{\frac{\sum fx^2}{N} - c_x^2} = \sqrt{\frac{1610}{108} - .79} = \sqrt{14.901 - .79} = 3.76$$

$$\sigma'_y = \sqrt{\frac{\sum fy^2}{N} - c_y^2} = \sqrt{\frac{861}{108} - .1174} = \sqrt{7.9722 - .1174} = 2.825$$

$$\sigma_x = (\sigma'_x) (S. I. x) = (3.76) (1) = 3.76$$

$$\sigma_y = (\sigma'_y) (S. I. y) = (2.825) (5) = 14$$

$$r = \frac{\sum xy - (c_x)(c_y)}{(\sigma'_x)(\sigma'_y)} = \frac{\frac{134}{108} - (-.889)(-.37)}{(3.76)(2.8)} = \frac{1.24 - .3289}{10.622} = \frac{.8421}{10.622} = .07927$$

$$= \frac{1.24 - .3289}{10.622} = \frac{.8421}{10.622} = .07927$$

ONE-WAY ANALYSIS OF VARIANCE

	College of Arts and Sciences	Professional Schools	Non- Majors	
$n_j =$	60	33	15	$N = 108$
$T_j =$	4953.1	2578.4	1254.6	$T = 8786.1$
$\bar{X}_j =$	81.0816	78.1353	83.64	$\frac{T^2}{N} = \frac{714773.64}{108}$
				$\frac{77195553.21}{108}$
$\sum_{i=1}^{n_j} X_{ij}^2 =$	422021.81	204591.76	91305.14	$= 717918.71$
$T_j^2/n_j =$	408886.6016	201958.9866	104934.744	$= 715279.3322$

Sum of Squares

$$(\sum T_j^2/n_j - T^2/N) \text{ Between } 715279.3322 - 714,773.6708 = 505.6914$$

$$(\sum_{j=1}^k \sum_{i=1}^{n_j} X_{ij}^2 - \sum_{j=1}^k \frac{T_j^2}{n_j}) \text{ Within } 717918.71 - 715,279.3322 = 2639.3778$$

$$(\sum_{j=1}^k \sum_{i=1}^{n_j} X_{ij}^2 - T^2/N) \text{ Total } 1433198.0422 - 1430,052.9730 = 3145.0692$$

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate
Between	505.6917	$(k-1)=2$	$252.8457=s_b^2$
Within	2639.3778	$(n-k)=105$	$25.1369=s_w^2$
TOTAL	769.0682	107	$F=10.0587^*$

*Since a significant F was found, the differences of means had to be located.

DUNCAN'S NEW MULTIPLE RANGE TEST

Within means square = 25.137

Harmonic mean

$$\frac{1}{n} = \frac{3}{\frac{1}{60} + \frac{1}{33} + \frac{1}{15}} = 26.785$$

Standard error of a single mean

$$s_{\bar{x}} = \frac{s}{\sqrt{n}} = \frac{5.01}{\sqrt{26.785}} = .968$$

Duncan's significant studentized ranges

<u>2 steps</u>	<u>3 steps</u>	
2.800	2.947	
2.710	2.853	(.05 level)
3.584	3.733	(.01 level)

	<u>College of Arts and Sciences</u>	<u>Professional Schools</u>	<u>Non- Majors</u>
Mean	83.64	81.08	78.13
83.64	---	2.56	5.61*
81.08		---	2.95**

* Significant at the .01 level

** Significant at the .05 level